

# Taxation, Bailouts and Financial Supervision

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## Abstract

This paper explores the interaction between foreign-debt bailout guarantees, financial supervision and optimal factor taxation. The context is that of a pre-“twin crises” emerging market economy and the analysis is undertaken using an original stylised two-period model based on the insights of the “third-generation” currency crisis literature. Bailout guarantees lead to moral hazard problems as banks monitor less and lend more than is socially desirable. As such, the solution of the government’s Ramsey taxation problem under bailouts entails a corrective rationale for capital taxation, implying a higher tax-rate than would otherwise be the case. When complementary regulatory instruments, such as effort-adjusted capital-requirements, are available to government, this capital tax-rate decreases with an increase in supervisory effectiveness. The paper’s conclusion is that bailout guarantees should only co-exist with some form of effective banking supervision to ensure that the effects of moral hazard are mitigated, which reinforces the view that emerging economies can signal their financial reputation and also contribute to reducing the risk of future crises only by implementing good governance and effective supervisory procedures in their financial systems.

*Keywords:* Twin Crises, Moral Hazard, Ramsey Taxation.

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# 1 Introduction

The consensus view that emerged from the analysis of the East Asian “twin crises” in 1990’s highlights the interaction between structural microeconomic problems and inappropriate macroeconomic policies as being a crucial determinant of these phenomena. The exact nature of this interaction is unclear, however. Two hypotheses are usually advanced to explain “twin crises” events: the first, stresses market failure, namely the sudden shift in market sentiment that rapidly propagated itself regionally and which lead to financial turmoil. According to this viewpoint, market turmoil was more severe due to policies of financial-market deregulation and of capital-account liberalisation in the affected economies; the second, focuses instead on government failure, both at a micro and macro level.

Common to both hypotheses, however, is the view that financial system fragility played an important role in explaining the “twin crises”, as is clear from the following inter-related stylised facts: first, governments provided either explicit or implicit bailout guarantees of liabilities denominated in foreign currency, which led banks to under-invest in risk management techniques and to overlend; second, banks failed to adequately hedge against foreign exchange rate risk, given the prevalence of fixed or *quasi*-fixed exchange rate arrangements; and, third, a lending boom usually preceded the occurrence of an exchange rate crisis. Taken together, these factors meant that the banking sector accumulated substantial foreign debt as it perceived itself to be immune from exchange rate risk. The financial system therefore became particularly prone to serious illiquidity problems in the event of a currency crisis. This state of affairs was further exacerbated by weak and/or inadequate financial supervision which could have mitigated the banking sector’s excessive risk-taking behaviour.

The present research is motivated by the fact that the taxation implications of “twin crises” have generally not been the subject of detailed analysis. Specifically, it explores the interaction between foreign-debt bailout guarantees, financial supervision and optimal factor taxation. Understanding this interaction is important since the implicit system of financial insurance provided by governments is equivalent to a stock of contingent public liabilities, which is not reflected in the deficit figures until the crisis occurs (Corsetti, Pesenti & Roubini, 1998). In other words, the bailout guarantees represent a serious burden on future fiscal imbalances even though fiscal deficits are low *ex-ante*. In turn, this observation suggests that the post-crisis budget situation is particularly relevant for the determination of taxation policy, especially when bailouts have to be honoured once a crises occurs.

The analysis is undertaken using an original stylised two-period model of an emerging economy in which government solves a Ramsey taxation problem. The analysis' main result establishes that the capital tax-rate is *higher* under bailout guarantees in comparison to the no bailout case. The reason is that there is a corrective-motive for capital taxation, in addition to the revenue-raising one that underpins government expenditure, i.e. a higher capital tax-rate will counteract the moral hazard induced increase in bank lending. Thus, the fact that taxation is distortionary is useful under bailout guarantees as it changes capital usage in the desired direction by ensuring that banks monitor more and lend less.

The remainder of the paper is organised as follows: section 2 briefly reviews the “twin crises” literature. Section 3 presents the analytical framework and establishes the nature of banking behaviour under bailout guarantees. The taxation issue is addressed in section 4, which also considers the effect of financial supervision on the optimal capital tax rate. Section 5 concludes. The appendix contains the proofs of propositions.

## 2 “Twin Crises” Stylised Facts

The nature and scope of the financial and currency crises in East Asia has motivated numerous studies which sought to determine the factors that caused these phenomena. By drawing upon some of these studies, this section seeks to identify the more relevant features of the “twin crises”.<sup>1</sup> Two hypotheses are usually advanced to explain crises events: the first, stresses market failure, namely the sudden shift in market sentiment that rapidly propagated itself regionally and which lead to financial turmoil. According to this viewpoint, market turmoil was more severe due to policies of financial-market deregulation and of capital-account liberalisation in the affected economies; the second, focuses instead on government failure, both at a micro and macro level. Common to both hypotheses, however, is the acceptance that financial system fragility played an important role in explaining the “twin crises”.

Financial fragility, in turn, is the outcome of the interplay of both structural *microeconomic* problems and inappropriate *macroeconomic* policies. This observation accords with Diaz-Alejandro's (1985) interpretation of the 1981-1983 Chilean crisis, which proved to be remarkably prophetic of the

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<sup>1</sup> As such, it does not purport to be a detailed survey of the “twin crises” literature. For a comprehensive introduction to this literature, refer to Sachs, Tornell & Velasco (1996), Chang & Velasco (1998a,b), Corsetti et al. (1998b,c), Edwards (1999), Eichengreen & Hausmann (1999), Kaminsky & Reinhart (1999) and Mishkin (1999).

East Asian “twin crises”. Not surprisingly, his insights have spawned an alternative approach to understanding financial and currency crises, the so-called “third-generation” models. These models differ sharply from earlier ones based solely on government’s macro-economic misbehaviour. “First-generation” models, for example, attribute the erosion of foreign exchange reserves and the eventual currency crash to large money-financed fiscal deficits (Krugman, 1979). Models of the “second-generation”, meanwhile, rely on government-initiated devaluations that seek to address a rise in unemployment and/or a growing external imbalance (Obstfeld, 1994).

In relation to inappropriate *macroeconomic* policies, the factors advanced in the literature include the choice of exchange rate regime, high current-account deficits, excessive capital inflows and loose fiscal policies. Sachs, Tornell & Velasco (1996) find, however, that these factors are generally not supported by the data, as do Frankel & Rose (1996). Moreover, there is no unique pattern of behaviour for basic macroeconomic variables in the buildup to a crisis. For example, the current account is not always in deficit while most government budgets were either in balance or even showed surpluses. The absence of fiscal imbalances, however, should not be interpreted as pervasive evidence against the fiscal roots of the East Asian crises. According to Corsetti, Pesenti & Roubini (1998), the implicit system of government-provided financial insurance is equivalent to a stock of contingent public liabilities, which is not reflected in the deficit figures until the crisis occurs. In other words, the bailout guarantees represent a serious burden on future fiscal imbalances even though fiscal deficits are low *ex-ante*.

Sachs et al. (1996) find instead that low foreign exchange reserves, a real exchange rate appreciation, a recent lending boom and the composition of capital inflows to be more important indicators of a country’s vulnerability to financial crises. Short-term capital inflows were found to be especially significant predictors of financial crises, as their composition can quickly render the domestic financial system internationally illiquid, i.e. when a country’s short-term foreign-currency liabilities exceed the amount of foreign currency that it can access in the immediate short-run.<sup>2</sup> In addition, most banks that intermediated the capital-inflows failed to adequately hedge against exchange rate risk. This failing meant that the financial system was also more prone to unfavourable movements in the exchange rate, as banks’ repayment burden effectively increased should the domestic currency depreciate.<sup>3</sup> Under this

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<sup>2</sup>Chang & Velasco (1998a) develop a model based on the illiquidity of the domestic financial system, which is a necessary and sufficient condition for financial crises to occur.

<sup>3</sup>According Eichengreen & Hausmann (1999), a fixed exchange rate is another example

circumstances, a liquidity crisis easily translated itself into a fully fledged currency crisis, which ultimately led to the collapse of the fixed exchange rate regime itself.

With respect to the role played by the domestic lending boom, two explanations are advanced. The first highlights the process of swift capital-account liberalisation that led to an influx of capital which was then intermediated by the banking sector. Sachs et al. (1996), however, suggests that there is no obvious correlation between the size of the capital inflow and the ensuing variation in bank credit, especially as many countries had opened their capital accounts for some time prior to the crisis' onset. Instead, weak financial-market regulation and supervision procedures, coupled with easier and cheaper external sources of funds, was found to be the more significant explanation of the lending boom as well as the increase in the riskiness of banks' portfolios. Not surprisingly, these conditions proved to be disastrous when market sentiment turned negative.

The last finding raises the issue of inappropriate *microeconomic* policies that were pervasive in the pre-crisis financial sectors and which resulted in financial fragility. These failures include weak financial regulation and lax supervision, low capital-adequacy ratios, the lack of incentive-compatible deposit insurance schemes, distorted incentives for project selection, corrupt lending practices and non-market criteria for the allocation of credit. In some economies, the inadequate financial supervision reflected the relationship nature of banking in which banks were able to successfully lobby banking regulators. In other instances, the poor supervision resulted from the lack of resources and the use of inadequate supervisory techniques (Mishkin, 1999).

In all cases, the direct consequence of this and other failings was the existence of significant moral hazard effects in the financial sector, e.g. unprofitable projects were re-financed through cheaper external borrowing because foreign creditors expected that domestic agents would be bailed by government in the event of a crisis. In turn, the perverse incentives due to moral hazard encouraged excessive risk-taking and the accumulation of short-term foreign debt. This interpretation of events in East Asia is advanced by Corsetti, Pesenti & Roubini (1998a,b), who argue that the moral hazard problem, allied with regulatory inadequacies and close links between private and public institutions, resulted in perverse incentives under which the corporate

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of an implicit government-provided guarantee against the risk of exchange-rate changes. For a theoretical model that considers the links between hedging, financial fragility and fixed exchange regimes, refer to Burnside, Eichenbaum & Rebelo (1999).

and financial sectors operated in the region. As such, the moral hazard effect magnified the financial vulnerability that followed financial-market liberalisation in the 1990's and exposed the region to macroeconomic and financial shocks.<sup>4</sup>

In the wake of the East Asian economic and financial turmoil, some important lessons have been learnt: first, fixed exchange rates are dangerous when large capital inflows co-exist with financial sector fragility; second, the lack of adequate regulation and financial supervision renders emerging economies more vulnerable to crises. As such, an effective supervisory system is essential to curtail excessive risk-taking by the banking system (Mishkin, 1999); third, policies that limit short-term foreign borrowing should be considered when conditions warrant it. In conclusion, it appears that government misbehaviour was a crucial determinant of the “twin crises” but not in the manner usually invoked. Indeed, in the case of East Asia, the orthodox explanations of governments running large deficits financed by the inflationary printing of money are not appropriate.

Instead, the implicit or explicit provision of bailout guarantees is more relevant given that their existence led to significant moral hazard effects in the predominantly bank-based economies. The moral hazard problem was further aggravated by the co-existence of inadequate financial supervision and fixed exchange rate regimes. Together, these factors led to financial fragility as the domestic banking system accumulated substantial foreign liabilities in order to finance its lending boom. It is this important insight which will motivate this study's analytical framework, as developed in the next section.

### 3 Economic Environment

The stylised economy lasts two periods ( $t = 1, 2$ ) and has a fixed exchange rate regime. The exchange rate is subject to a possible devaluation shock in  $t = 2$ , which introduces *macroeconomic* uncertainty into the economy. There are two types of households, *vis.* workers and bankers (hereafter banks). Let  $J$  denote the unit-measure set of banks and assume, without loss of generality, that the set of workers is of the same measure. A representative bank is endowed with homogenous skills and capital that allows it to offer banking services. It also enjoys full and exclusive access to international financial markets.

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<sup>4</sup>For models based on the moral hazard interpretation, see Cosetti et. al. (1998a) and Chinn & Kletzer (2000).

Workers' financial market participation is limited to their savings in the form of interest-bearing bank deposits. Banks act as typical financial intermediaries by transforming deposits into loans, which then fund firms' production plans. Domestic savings are, however, insufficient to fund production plans and so bank loans are partially financed by foreign-currency debt. The bank's exchange rate risk is not hedged by assumption. Finally, banks face a *microeconomic* risk which occurs when firms are unsuccessful in setting up their borrowed capital and so default on their loans.

Let  $s_t$  denote the stochastic state of the world at time  $t$ , where  $s_t$  follows a time-invariant Markov chain. A state of the world consists of *macroeconomic* uncertainty, due to the risk of exchange rate devaluation, and *microeconomic* uncertainty regarding the performance of banks' loan portfolios. In the first state ( $s_t = 1$ ), the economy has a high loan-performance regime and an exchange rate of  $E_1 = 1$ . The proportion of loans that honour their contractual obligations in this state is  $0 < \lambda_1 < 1$ . In the second ( $s_t = 2$ ), the economy switches to a low loan-performance regime with  $0 < \lambda_2 < 1$  and simultaneously experiences a devaluation shock ( $E_2 > E_1$ ). The two shocks are positively correlated in order to capture the stylised feature of poorer loan-portfolio performance in the post-devaluation economic environment, hence  $\lambda_2 < \lambda_1$ . The probability transition matrix is given by

$$T = \begin{bmatrix} 1 - q & q \\ 0 & 1 \end{bmatrix}$$

where  $q = \Pr(s_t = 2 | s_t = 1)$  denotes the probability of switching to  $s_t = 2$  at time  $t$  conditional on it having been in  $s_t = 1$  before.<sup>5</sup>

### 3.1 Agents' Preferences and Constraints

Workers are identical with respect to endowments and consumption preferences. Each worker is endowed with a non-stochastic, tax-exempt capital endowment ( $k^W > 0$ ) in  $t = 1$  and with one unit of leisure in  $t = 2$ . A worker can decide to forego some of his leisure endowment in exchange for a wage which he earns by supplying labour to firms during  $t = 2$ . A representative

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<sup>5</sup>Note that this characterisation implies that  $s_1 = 1$  occurs with probability one and that only two histories ( $s^t$ ) are possible during  $t = 2$ , i.e.  $s^2 = [s_2 = 2, s_1 = 1]$  and  $s^2 = [s_2 = 1, s_1 = 1]$ , which occur with probabilities  $0 < q < 1$  and  $(1 - q)$  respectively. In general, an economy's history at time  $t$  is given by the set  $s^t = [s_t, s_{t-1}, \dots, s_1]$ . The probability of a particular history  $s^t$  occurring at time  $t$ , conditional on the observed initial state  $s_1$ , is denoted by  $\pi(s^t | s_1)$ .

worker's lifetime expected utility is given by

$$U(c^W) = \sum_{s^t} \pi(s^t|s_1) \{u(c_1^W(s^t)) + \delta[u(c_2^W(s^t), 1 - n(s^t))]\} \quad (1)$$

where  $\delta \in (0, 1)$  is the intertemporal subjective discount rate. A worker's consumption in period  $t$  is denoted by  $c_t^W(s^t)$  while his labour supply is denoted by  $n(s^t)$ . The momentary utility function  $u(\cdot, \cdot)$  is twice continuously differentiable, concave and separable in its arguments.

The worker's problem is to choose his level of consumption for each period and his supply of labour in  $t = 2$ . The return on savings and wages are a worker's sole sources of income during  $t = 2$ , and so his budget constraints are given by

$$c_1^W(s^t) + d(s^t) \leq k^W \quad (2)$$

$$c_2^W(s^t) \leq R(s^t)d(s^t) + (1 - \tau(s^t))w(s^t)n(s^t) \quad (3)$$

where  $d(s^t)$  are his deposits,  $R(s^t) = 1 + r(s^t)$  is the gross interest rate,  $w(s^t)$  are wages and  $\tau(s^t)$  is the labour tax-rate.

A bank has an initial endowment of capital ( $k^B > 0$ ) and risk neutral preferences, so that its expected lifetime utility is given by

$$V(c^B) = \delta \sum_{s^t} \pi(s^t|s_1) v(c_2^B(s^t)) \quad (4)$$

where  $v(\cdot)$  is the momentary utility function and  $c_2^B(s^t)$  denotes a bank's consumption in  $t = 2$ . In the first period, a bank solves its banking game (discussed below) in order to determine its optimal monitoring and lending levels. It is assumed that the sum of a bank's capital endowment and its deposits is insufficient to fund the total volume of firms' investment plans for all monitoring levels. The required shortfall, denoted by  $l^*(s^t)$ , is thus borrowed in international capital markets at an exogenous gross interest rate ( $R^*$ ) which is payable in  $t = 2$ . The foreign loan is subsequently converted into domestic currency at the exchange rate of  $E_1$ . Under these assumptions, a bank's budget constraints are given by

$$l(s^t) \leq d(s^t) + l^*(s^t) + k^B \quad (5)$$

$$c_2^B \leq \Pi^B(e, l, r^l, s^t) \quad (6)$$

where  $l(s^t)$  denotes a bank's lending level and  $\Pi^B(e, l, r^l, s^t)$  its profit function, which is presented and discussed in the appendix.



### 3.2 Government

The government undertakes no spending in  $t = 1$  but expends an exogenous amount  $g(s^t) \geq 0$  in  $t = 2$ . It is assumed that only a second-best tax system is available to the government in which taxes are chosen so as to minimise tax-induced distortions, i.e. Ramsey taxation.<sup>6</sup> Expenditure is therefore financed by taxing capital and labour at flat-rates  $z(s^t)$  and  $\tau(s^t)$  respectively.

Moreover, the use of second-best taxation presupposes that the government can commit itself to its announced fiscal policy. As such, the government does not adjust  $g(s^t)$  *ex-post* so as to avoid raising the revenue needed to finance total expenditure. The commitment assumption also precludes the government from dishonouring its bailout obligations.

Note that stochastic determination of the world's state in  $t = 2$  constitutes an exogenous shock to the government's budget constraint. In other words, it will potentially expend an amount in bailouts  $B(s^t) > 0$  when  $s_t = 2$  and zero otherwise. The government's budget constraint in  $t = 2$  is thus given by

$$g(s^t) + B(s^t) \leq z(s^t)r^l(s^t)k(s^t) + \tau(s^t)w(s^t)n(s^t) \quad (7)$$

where  $k(s^t)$  denotes capital usage and  $r^l(s^t)$  the rental rate of capital.<sup>7</sup>

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<sup>6</sup>For an introduction into the optimal taxation literature, see Judd (1985), Chamley (1986), Bovenberg (1994), Zhu (1997) and Renström (1999).

<sup>7</sup>Following Chamley (1986), tax-rates are viewed as the relevant decision variables when government solves its Ramsey taxation problem. Hence, the two pairs of numbers  $(\tau(s^t), z(s^t))$  and  $(w(s^t), r^l(s^t))$  are reduced to just one pair by utilising the firm's first-order conditions (FOC) and the equilibrium factor-market outcomes:

$$\begin{aligned} \tilde{r}^l(s^t) &= (1 - z(s^t))r^l(s^t) \\ \tilde{w}(s^t) &= (1 - \tau(s^t))w(s^t) \end{aligned}$$

Given the production function's linear homogeneity properties, government revenues can then be rewritten as

$$\begin{aligned} (r^l(s^t) - \tilde{r}^l(s^t))k(s^t) + (w(s^t) - \tilde{w}(s^t))n(s^t) \\ = Q(k(s^t), n(s^t)) - \tilde{r}^l(s^t)k(s^t) - \tilde{w}(s^t)n(s^t) \end{aligned} \quad (7')$$

after directly incorporating the firm's FOC into the budget constraint.

### 3.3 Firms

Production is undertaken by a continuum of identical firms with measure one. A typical firm lacks the capital needed to initiate production and so seeks a loan from a single bank during  $t = 1$ . In the absence of any uncertainty at this stage, the loan application receives the requested financing. The firm then proceeds to set up its borrowed capital and, if successful, will begin production during  $t = 2$ . If not, the borrowed capital is completely dissipated and the firm will default on its contractual obligations.

Each firm operates an identical technology that produces a single homogenous good using the borrowed capital and labour, which is hired in a competitive market. The production function, denoted by  $Q(\cdot)$ , is strictly concave and linearly homogenous. A representative firm maximises its profit function,

$$\Pi^F = Q(k(s^t), n(s^t)) - r^l(s^t)k(s^t) - w(s^t)n(s^t)$$

by choosing the optimum levels of each production factor. In doing so, it takes as given the market-determined rental rates of labour and of capital. The FOC of the firm's problem are given by

$$r^l(s^t) = Q_k(s^t) \tag{8}$$

$$w(s^t) = Q_n(s^t) \tag{9}$$

where subscripts denote here, as elsewhere, the partial derivatives of the functions under consideration.<sup>8</sup> As usual, the FOC imply that factor inputs are employed up till the point where each factor's marginal product equals its respective rental price. Upon aggregation, equilibrium condition (8) yields the demand schedule for bank loans, denoted by  $D(r^l)$ , which is positive and decreasing in  $r^l$ , given the above assumptions.

## 4 Banking in a Small Open Economy

### 4.1 Banking Game

The timing of the banking game (see Figure 1) is as follows: at the beginning of  $t = 1$ , the government commits itself to a specific fiscal policy. At the same time, the banking regulator announces the regulatory regime to be

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<sup>8</sup>In order to ensure that  $0 < Q_k(s^t) < 1$  in equilibrium, the economy is assumed to be subject to a minimum capital utilisation constraint or, equivalently, a minimum production constraint.

implemented. Firms then apply for loans which are supplied at the equilibrium market rate. After lending has taken place, microeconomic uncertainty is introduced when Nature privately reveals to firms their likelihood of a successful capital set-up process in  $t = 2$ . In the game's next-to-last stage, banks choose their optimum level of monitoring and decide which loans are to be recalled.<sup>9</sup> Finally, Nature determines whether or not the exchange rate is devalued in  $t = 2$  and, in doing so, introduces macroeconomic uncertainty into the game.

A bank cannot observe the outcome of a firm's capital set-up process and so, from its perspective, the risk of loan default is post-contractual in nature. With the advent of microeconomic uncertainty, a bank's portfolio comprises firms that will repay their loans but also some that will not. In order to improve the expected return on lending, a bank will monitor its loan portfolio prior to the onset of the capital set-up phase.

This improvement is possible because banks have exclusive access to a monitoring technology that *imperfectly* classifies firms on the basis of their success in setting-up the borrowed capital: a "good" firm is expected to succeed while a "bad" one is expected to fail. "Bad" firms are shutdown *after* the firm has observed its type but *before* it proceeds to the capital set-up stage, thereby allowing a bank to recover its lent capital.

In other words, monitoring improves the expected return on lending because the *final* composition of a bank's loan portfolio contains a *greater* proportion of "good" firms when compared to the initial composition, given that it recovers the capital lent to firms classified as "bad". However, a bank also loses out on a higher return when it wrongly shuts down a "good" firm. As such, this trade-off will have to be taken into account (in conjunction with monitoring costs) when banks decide their optimal level of monitoring. For the formal specification and discussion of banking technology, refer to the appendix.

## 4.2 Banking Equilibrium

The banking industry is assumed to be competitive so each bank is a price taker both in lending and in deposit rates. For a given capital taxation policy, a banking industry equilibrium is defined as follows:

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<sup>9</sup>Banking models based on asymmetric informational differences typically focus on the optimal contract that solves either an adverse selection or a moral hazard problem. Here, the focus will instead be on banks' actual monitoring and lending behaviour.

**Definition 1:** An equilibrium for the banking industry is a level of monitoring ( $\hat{e}$ ), a level of lending ( $\hat{l}$ ) and a lending rate ( $r^l$ ) such that

- (i) the pair  $(\hat{e}, \hat{l})$  maximises the bank's expected profit;
- (ii) the bank's expected profit is zero.
- (iii) the lending rate  $r^l$  clears the market for loans.

#### 4.2.1 No Bailout Guarantees

The banking game is solved using backward induction. As such, a bank first chooses the level of monitoring effort from its opportunity set  $\Phi(\bar{\lambda})$  (defined in the appendix) so as to maximise objective function (4) subject to constraints (5) and (6). Then, it proceeds to determine the level of lending, taking as given the optimal level of monitoring. The following proposition characterises the banking equilibrium when bailout guarantees do not exist:

**Proposition 1** *The banking equilibrium without bailout guarantees is unique and has the following properties:*

- (1) The optimal level of monitoring,  $\hat{e}^s$ , is given by

$$\alpha'(\hat{e}^s)\bar{\lambda}\tilde{r}_s^l - \beta'(\hat{e}^s)(1 - \bar{\lambda}) = c'(\hat{e}^s) \quad (10)$$

- (2) The optimal level of lending,  $\hat{l}^s$ , is given by

$$\hat{l}^s = F(\hat{e}^s, \tilde{r}_s^l, \bar{\lambda}) - \bar{E}R^* \quad (11)$$

- (3) The equilibrium lending rate,  $r_s^l$ , is given by

$$\int_{j \in J} \hat{l}^s = D(r_s^l) \quad (12)$$

**Proof.** Refer to the appendix. ■

The economic intuition underlying (10) is simple: in equilibrium, monitoring effort is expended until the marginal benefit of monitoring equals its marginal cost. The total marginal benefit comprises two elements: the increased return on lending due to the higher proportion of “good” firms contained in the *final* composition of a bank's loan portfolio; and, the reduction in potential default losses as a result of the “bad” loans that are correctly recalled. By design, banking behaviour here is unaffected by bailout guarantees. As such, the banking game's outcome is accordingly designated as the social solution, where  $\hat{e}^s$  denotes the social monitoring level and  $\hat{l}^s$  the social lending level. Finally, note that equation (10) implicitly defines the function  $\hat{e}^s(\bar{\lambda}, \tilde{r}_s^l)$ , given that the conditions of the implicit function theorem are satisfied (refer to the appendix).

#### 4.2.2 Bailout Guarantees

A bank finds it optimal to default on foreign-debt loans when its profit is negative, i.e. when the combined effect of an exchange rate devaluation and of a lower loan-repayment rate in the second state lead to a loss (see assumption A1). When this happens, a bank declares bankruptcy and will not pay foreign creditors, nor will it pay itself the opportunity cost of being in banking.<sup>10</sup> Upon bankruptcy, the bank's remaining assets are appropriated by the government who first proceeds to pay out domestic depositors and then foreign creditors. The bailout amount will therefore be the difference between a bank's foreign debt and its net worth at that time, i.e.<sup>11</sup>

$$B(s^t) = [E_2 R^* - F(\hat{e}^p, \tilde{r}_p^l, \lambda(s^t))]k(s^t) + \varphi(k(s^t)) - E_2 R^* k^B \quad (13)$$

When bailout guarantees exist, a bank's objective function is given by

$$V = (1 - q)\Pi^B(e, l, \tilde{r}^l, \lambda_1) + q \max\{\Pi^B(e, l, \tilde{r}^l, \lambda_2), 0\} \quad (14)$$

As before, a representative bank's problem is to first choose the effort level that maximises (14), where the opportunity set is now defined by  $\Phi(\lambda_1)$ , and then its optimal lending level.

**Proposition 2** *The banking equilibrium with bailout guarantees is unique and has the following properties:*

- (1) The optimal level of monitoring,  $\hat{e}^p$ , is given by

$$\alpha'(\hat{e}^p)\lambda_1 \tilde{r}_p^l - \beta'(\hat{e}^p)(1 - \lambda_1) = c'(\hat{e}^p) \quad (15)$$

- (2) The optimal level of lending,  $\hat{l}^p$ , is given by

$$\hat{l}^p = F(\hat{e}^p, \tilde{r}_p^l, \lambda_1) - E_1 R^* \quad (16)$$

- (3) The equilibrium lending rate,  $r_p^l$ , is given by

$$\int_{j \in J} \hat{l}^p = D(r_p^l) \quad (17)$$

**Proof.** Refer to the appendix. ■

<sup>10</sup>For the sake of simplicity, defaults are taken to be costless. This assumption does not qualitatively affect the analysis' results.

<sup>11</sup>The bank's net worth is equal to  $F(\hat{e}^p, \tilde{r}_p^l, \lambda(s^t))k(s^t) - \varphi(k(s^t)) - R(s^t)d(s^t)$ .

Let  $\hat{e}^p$  denote the private optimal monitoring level and  $\hat{l}^p$  the private optimal lending level. Note that equation (15) implicitly defines the function  $\hat{e}^p(\lambda_1, \tilde{r}_p^l)$ , which differs from  $\hat{e}^s(\bar{\lambda}, \tilde{r}_s^l)$  derived previously. The exact relationship between monitoring and lending behaviour with and without bailout guarantees is established in the following proposition:

**Proposition 3 (Existence of Moral Hazard)** *The existence of bailout guarantees leads to a lower level of monitoring and a higher level of lending.*

**Proof.** This result is derived using a comparative static analysis that studies the impact of changes in the loan repayment rate ( $\lambda$ ) on the endogenous variables (refer to the appendix for full details). The analysis establishes that the optimal level of monitoring and the lending rate are both *decreasing* functions of  $\lambda$  whilst the optimal lending level is an *increasing* function. As such, lending under bailout guarantees is higher ( $\hat{l}^p > \hat{l}^s$ ) and the lending rate lower ( $\tilde{r}_p^l < \tilde{r}_s^l$ ), for a given capital tax-rate. Moreover, optimal monitoring is an *increasing* function of the equilibrium lending rate. Together, these results imply that  $\hat{e}^p(\lambda_1, \tilde{r}_p^l) < \hat{e}^p(\lambda_1, \tilde{r}_s^l) < \hat{e}^s(\bar{\lambda}, \tilde{r}_s^l)$ . ■

The economic intuition of the above result is that bailout guarantees effectively insure banks against both exchange rate and loan default risk, as is to be expected. Consider, for example, their impact on monitoring. For a given lending level and lending rate, a bank's private marginal curve will always lie *below* the social marginal revenue curve, as shown in Figure 2. Marginal revenue will therefore be *lower* whenever the loan repayment rate is higher, for all effort levels.<sup>12</sup> Since private monitoring is determined by  $\lambda_1$  whilst social monitoring is determined by the *lower* repayment rate,  $\bar{\lambda}$ , the private solution will entail a *lower* monitoring level in equilibrium. In other words, monitoring is simply less rewarding economically when bailout guarantees exist.

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<sup>12</sup>Letting  $\lambda$  denote a generic repayment rate, the total revenue function is given by  $TR = (1 + \alpha(e)\lambda\tilde{r}^l - \beta(e)(1 - \lambda))l$  while the marginal revenue associated with additional monitoring is  $TR_e = (\alpha'(e)\lambda\tilde{r}^l - \beta'(e)(1 - \lambda))l$ . Under the assumptions made in this paper,  $TR_{e\lambda} = (\alpha'(e)\tilde{r}^l + \beta'(e))l < 0$  and  $TR_\lambda = \alpha(e)\tilde{r}^l + \beta(e)l > 0$ .

## 5 Factor Taxation

### 5.1 Ramsey Problem

Recall that the government's exogenous expenditure in period  $t = 2$  is financed entirely by tax revenues obtained using distortionary flat-rate taxes on capital and labour. Formally, the government's Ramsey problem is to determine the optimal level of capital and labour tax-rates at the beginning of period  $t = 1$ . The elements that make up the Ramsey problem are as follows:

**Definition 2:** A feasible allocation is the set  $\{c_1^W(s^t), c_2^W(s^t), c_2^B(s^t), g(s^t), k(s^t), n(s^t)\}$  which satisfies the government's resource constraint.

**Definition 3:** A price system is the set  $\{w(s^t), r^l(s^t), r(s^t)\}$  whose elements are non-negative.

**Definition 4:** A government policy is the set  $(g(s^t), B(s^t), \tau(s^t), z(s^t))$  whose elements are non-negative.

**Definition 5:** A competitive equilibrium is a feasible allocation, a price system, and a government policy such that

- (i) given the price system and government policy, the allocation solves both the bank's problem and the worker's problem; and
- (ii) given the allocation and price system, the government's policy satisfies the government's budget constraint.

The Ramsey problem is motivated by the multiplicity of competitive equilibria, each indexed by a different government policy:

**Definition 6:** Given agents' aggregate capital endowment  $(k^{agg})$ , the government's Ramsey problem is to choose a competitive equilibrium that maximises its social welfare function.

The government solves the Ramsey problem by maximising the social welfare function subject to budget constraint (7), its resource constraint and the equilibrium behavioural responses of the private sector. The resource constraint at the beginning of  $t = 2$  is given by

$$g(s^t) + B(s^t) \leq [F(e, r^l, \lambda(s^t)) - E(s^t)R^*]k(s^t) - \varphi(k(s^t)) + R(s^t)k^{agg} + w(s^t)n(s^t) - [R(s^t)c_1^W(s^t) + c_2^W(s^t) + c_2^B(s^t)] \quad (18)$$

The agents' equilibrium behavioural constraints must also be included as the government needs to take their reaction to the tax system into account when

designing its optimal taxation policy.<sup>13</sup> The Lagrangean formulation of the Ramsey problem at time  $t = 1$  is as follows:

$$\begin{aligned}
L = & \sum_{s^t} \pi(s^t|s_1) \{ \theta [u(c_1^W(s^t)) + \delta(u(c_2^W(s^t), 1 - n(s^t)))] + (1 - \theta) \delta v(c_2^B(s^t)) \\
& + \mu_1 R^{-1}(s^t) [Q(k(s^t), n(s^t)) - \tilde{r}^l(s^t)k(s^t) - \tilde{w}(s^t)n(s^t) - B(s^t) - g(s^t)] \\
& + \mu_2 [k^{agg} - c_1^W(s^t) + R^{-1}(s^t) (((F(e, r^l, \lambda(s^t)) - E(s^t)R^*))k(s^t) - \varphi(k(s^t)) \\
& \quad + w(s^t)n(s^t) - c_2^W(s^t) - c_2^B(s^t) - B(s^t) - g(s^t))] \\
& + \eta_1 [\delta u_c(c_2^W(s^t), 1 - n(s^t)) - R^{-1}(s^t)u_c(c_1^W(s^t))] \\
& + \eta_2 [R^{-1}(s^t)u_c(c_1^W(s^t))\tilde{w}(s^t) - \delta u_n(c_2^W(s^t), 1 - n(s^t))] \\
& + \eta_3 [\delta(F(e, \tilde{r}^l, \lambda(s^t)) - E(s^t)R^* - \varphi_k(k(s^t)))] \\
& + \eta_4 [\delta(F_e(e, \tilde{r}^l, \lambda(s^t))k(s^t))] \} \tag{19}
\end{aligned}$$

where  $0 < \theta \leq 1$  is the weight attached to the utility of workers and where  $\eta_i$  ( $i = 1, 2, 3, 4$ ) are the multipliers associated with agents' behavioural constraints. The Lagrangean multiplier of the government's budget constraint is denoted by  $\mu_1$  while that of its resource constraint is  $\mu_2$ .<sup>14</sup>

Consider now the government's problem when bailout guarantees do not exist, so that  $B(s^t) = 0$  in (19). The situation is particularly relevant as it will provide a natural benchmark against which to compare the solution obtained when bailout guarantees exist, which is discussed further on.

**Proposition 4** *The labour and capital tax-rates are non-negative in the absence of bailout guarantees.*

**Proof.** Refer to the appendix for details. Let  $E[x(s^t)] \equiv \sum_{s^t} \pi(s^t|s_1)x(s^t)$  denote the mathematical expectation conditional upon the information available at time  $t = 1$ . Consider first capital taxation: the FOC that implicitly defines the optimal tax-rate (in expected value terms) is given by (A11),

$$\eta_3 = E[R^{-1}(s^t) [\mu_1(r_s^l(s^t) - \tilde{r}_s^l(s^t)) + \mu_2(F(\hat{e}^s, r_s^l, \lambda(s^t)) - F(\hat{e}^s, \tilde{r}_s^l, \lambda(s^t)))] \tag{20}$$

after equations (8) and (11) have been substituted into it. To obtain the desired result, note that  $E[R^{-1}(s^t)(r_s^l(s^t) - \tilde{r}_s^l(s^t))] \geq 0$  (by definition) and

<sup>13</sup>For the derivation of these constraints, refer to equations (A3)-(A9) in the appendix.

<sup>14</sup>Note that agents' budget constraints are not explicitly included as these become redundant when the government satisfies its budget constraint and when the resource constraint holds.



that  $E[R^{-1}(s^t)(F(\hat{e}^s r_s^l, \lambda(s^t)) - F(\hat{e}^s, \tilde{r}_s^l, \lambda(s^t)))] \geq 0$  due to fact that  $\frac{d\hat{e}_s}{dz} < 0$  when evaluated at  $\hat{e}_s$ . Finally,  $\eta_3$  is always non-negative and only positive when the corresponding constraint is binding. Hence, the FOC is only satisfied when the sum of the RHS above is non-negative, i.e. if  $r_s^l(s^t) \geq \tilde{r}_s^l(s^t)$  or equivalently, when  $z(s^t) \geq 0$ . Similar reasoning applies to the taxation of labour when using (A10) so that  $\tau(s^t) \geq 0$ . ■

The above proposition establishes a revenue-raising motive for factor taxation when  $g(s^t) > 0$ . The reason for this is clear upon inspection of (20), which has a simple interpretation:  $E[R^{-1}(s^t)(r_s^l(s^t) - \tilde{r}_s^l(s^t))]$  is expected capital revenue while  $E[R^{-1}(s^t)(F(\hat{e}^s, r_s^l, \lambda(s^t)) - F(\hat{e}^s, \tilde{r}_s^l, \lambda(s^t)))]$  is the tax-induced distortion in bank lending. Here, a marginal increase in the capital tax-rate will increase revenue but will also reduce lending or, equivalently, capital usage. The social marginal value of these two terms is given by  $\mu_1$  and  $\mu_2$  respectively. In equilibrium, the weighted sum of these two effects must be non-negative when discounted back to  $t = 1$ .<sup>15</sup>

**Proposition 5** *When bailout guarantees exist, the labour tax-rate is non-negative while the capital tax-rate is strictly positive.*

**Proof.** Government bailouts do not affect the FOC of labour (A10), hence the optimal labour tax-rate will remain unchanged. However, the same is not true of capital as the relevant FOC is now given by:

$$\eta_3 + \mu_1 E[R^{-1}(s^t)B_k(s^t)] = \mu_1 E[R^{-1}(s^t)(r_p^l(s^t) - \tilde{r}_p^l(s^t))] + \mu_2 E[R^{-1}(s^t)(F(\hat{e}^p, r_p^l, \lambda(s^t)) - F(\hat{e}^p, \tilde{r}_p^l, \lambda(s^t)))] \quad (21)$$

Note that expected capital revenue is affected by

$$B_k(s^t) = [E_2 R^* - F(\hat{e}^p, \tilde{r}_p^l, \lambda(s^t))] + \varphi_k(k(s^t))$$

which is positive for all  $k(s^t) > 0$ , given assumption (A1). After applying the reasoning used in the proof of proposition 4, it is clear that  $r_p^l(s^t) > \tilde{r}_p^l(s^t)$  since  $E[R^{-1}(s^t)B_k(s^t)] > 0$  necessarily implies that the RHS of (21) must also be positive, hence  $z(s^t) > 0$ . ■

This last result implies that the capital tax-rate under bailout guarantees is *higher* than that which would hold when these do not exist. The reason is that there is now a corrective-motive for capital taxation, in addition to the

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<sup>15</sup>When the capital and labour tax-rates are set to zero, this is tantamount to asserting that  $g(s^t) = 0$ , which also corresponds to the Pareto-efficient market outcome.

revenue-raising one discussed earlier. As before, a marginal increase in the capital tax-rate increases revenue but reduces capital usage at the same time. Unlike the case of no bailouts, however, there is also an *increase* in expected revenue due to the marginal reduction of the bailout amount in response to the tax-induced decline in capital usage, i.e.  $B_k(s^t) > 0$ . The net effect on expected revenue is given by  $E[R^{-1}(s^t)(r^l(s^t) - \hat{r}^l(s^t)) - B_k(s^t)]$ . The optimal capital tax-rate is therefore set at a level which ensures that the weighted sum of two effects is non-negative when discounted back to  $t = 1$ .

In other words, the fact that taxation is distortionary is useful here as it will change capital usage in the desired direction. This corrective rationale implies that a positive capital tax-rate, in effect, counteracts the increased lending induced by the moral hazard effect of bailout guarantees. The desirability of relying exclusively on capital taxation to mitigate moral hazard is questionable, however, if one bears in mind that a positive capital tax-rate will also reduce the level of production in the economy. This observation suggests that moral hazard might be better addressed with the use of alternative instruments. The next section looks at one such instrument, namely financial supervision, in order to assess its ultimate impact on the optimal capital tax-rate under bailout guarantees.

## 5.2 Financial Supervision

Financial supervision is able to mitigate moral hazard when it is effective. Supervisory effectiveness, in turn, is dependent upon the choice of regulatory regime. The issue of regulatory design is, however, too extensive and beyond the scope of this paper. As such, the analysis considers a simple regulatory regime, namely an effort-adjusted capital requirement. The regime choice is motivated by the fact that it is an incentives-based regulatory scheme, which will allow for the analysis of its impact on banks' monitoring behaviour. Moreover, its enforceability depends on a varying degree of supervisory effectiveness, which accords with the stylised fact of weak and inadequate financial supervision in the countries affected by "twin crises".

### 5.2.1 Supervision Technology

The banking regulator can neither observe a bank's actual monitoring level nor infer it from its level of lending. She must therefore make use of an imperfect supervision technology in order to ensure that the capital-requirement

is implemented.<sup>16</sup> Let  $\tilde{e}$  denote the regulator's perception of a bank's monitoring level, which is formed as follows:

$$\tilde{e} = (1 - \gamma)\hat{e}^s + \gamma e \quad 0 \leq \gamma < 1 \quad (22)$$

The intuition of this formulation is that the accuracy of the regulator's perception is determined by technical and institutional factors, which are captured by the parameter  $\gamma$ . For example, completely inadequate supervision ( $\gamma = 0$ ) implies that the regulator incorrectly perceives a bank to be pursuing  $\hat{e}^s$ . On the other hand, her perception becomes increasingly more accurate as  $\gamma \rightarrow 1$ , which corresponds to greater supervisory effectiveness. An alternative interpretation of financial supervision is obtained by rewriting (22) as

$$\hat{e}^s - \tilde{e} = \gamma(\hat{e}^s - e) \quad (22')$$

Here, supervision provides the regulator with an estimate of the moral hazard effect  $(\hat{e}^s - e)$ , which is more plausible in informational terms as the regulator need not know either  $\hat{e}^s$  or  $e$ .

### 5.2.2 Capital Requirements

When designing the capital requirement, the regulator must take a bank's response to it into account. Specifically, she must ensure that a bank has a positive incentive to pursue a level of monitoring greater than  $\hat{e}^p$  when the capital requirement is in force. With this in mind, the appropriate effort-adjusted capital requirement is given by

$$k_{cr}^B(\tilde{e}) = \frac{\varphi(l) + (E_2 R^* - F(\tilde{e}, \tilde{r}^l, \lambda_2))l}{E_2 R^*} \quad \forall e \in (\hat{e}^p, e^o(\lambda_1, \lambda_2)) \quad (23)$$

as shown in the appendix. In a nutshell, the economic rationale underlying (23) is that increased monitoring will *decrease* a bank's loss in the second state, which constitutes a positive incentive. In other words, an increase in a bank's monitoring effort will *reduce* the capital-requirement it will have to comply with. When implemented, it has the following effect on banking behaviour under bailout guarantees:

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<sup>16</sup>The supervision technology described here is based on Khambu (1990), who studies regulatory effectiveness when risk is concealable from the banking regulator.

**Proposition 6** *The banking equilibrium under an effort-adjusted capital requirement regime has the following properties:*

- (i) *the monitoring level is greater,*
- (ii) *the lending level is lower, and*
- (iii) *the lending rate is greater*

*when compared to the no banking-regulation case.*

**Proof.** The FOC w.r.t. monitoring is given by (A14') which implicitly defines the optimal monitoring level under a capital-requirement, denoted by  $\hat{e}^{cr}(\lambda_1, \lambda_2, \gamma, \tilde{r}_{cr}^l)$ , where  $\tilde{r}_{cr}^l$  is the equilibrium interest rate. The first result follows from the design of the capital-requirement (refer to the appendix). Note that  $\hat{e}^{cr}$  is bounded from below by  $e^p(\lambda_1, \tilde{r}_p^l)$ , as the solution of (A14') is identical to that of (15) when  $\gamma = 0$ . Similarly, it is bounded from above by  $\hat{e}^s(\bar{\lambda}, \tilde{r}_s^l)$  since  $\hat{e}^{cr} \rightarrow \hat{e}^s(\bar{\lambda}, \tilde{r}_s^l)$  when  $\gamma \rightarrow 1$ . The remaining results follow from the comparative static results derived earlier, together with the fact that  $\hat{e}^p(\lambda_1, \tilde{r}_p^l) \leq \hat{e}^{cr}(\lambda_1, \lambda_2, \gamma, \tilde{r}_{cr}^l) < \hat{e}^s(\bar{\lambda}, \tilde{r}_s^l)$ . ■

The above proposition establishes that an effort-adjusted capital requirement regime is capable of mitigating the moral hazard effect. However, the extent to which moral hazard is mitigated depends on the effectiveness of financial supervision. When it is ineffective ( $\gamma = 0$ ), a bank's monitoring level does not differ from the outcome of the no-regulation case. The exact relation between supervisory effectiveness and the capital tax-rate is contained in the next proposition:

**Proposition 7** *The optimal capital tax-rate is highest whenever financial supervision is least effective, and conversely.*

**Proof.** The optimal capital tax-rate is a *decreasing* function of monitoring effort, as shown in the appendix. This fact, in conjunction with  $\hat{e}^p(\lambda_1, \tilde{r}_p^l) < \hat{e}^{cr}(\lambda_1, \lambda_2, \gamma, \tilde{r}_{cr}^l) < \hat{e}^s(\bar{\lambda}, \tilde{r}_s^l)$ , establishes the result. ■

## 6 Conclusion

This paper explores the interaction between foreign-debt bailout guarantees, financial supervision and optimal factor taxation. The context is that of a pre-“twin crises” emerging market economy characterised by a fixed exchange rate regime. The analysis is undertaken using an original model that seeks to incorporate the relevant stylised facts of “twin crises”. With this in mind, a model of banking is developed where banks monitor their loan portfolios in

order to improve the expected rate of return. The existence of foreign-debt bailouts effectively provide banks with a safety net and so are subject to moral hazard.

The reason for this is that banks consider themselves to be immune from unfavourable outcomes associated with the higher loan default rate and the exchange rate shock in the second state. In other words, banks have increased incentives for less monitoring and more lending when compared to the socially desirable case. In addition, the quality of their loan portfolios is manifestly inferior, as the *ex-post* portfolio composition contains a higher proportion of loans that perform poorly when economic conditions are unfavourable.

The analysis' main result establishes that the capital tax-rate is *higher* under bailout guarantees in comparison to the no bailout case. The reason is that there is a corrective-motive for capital taxation, in addition to the revenue-raising one that underpins government expenditure, i.e. a higher capital tax-rate will be needed to counteract the moral hazard induced increase in bank lending. In other words, the fact that taxation is distortionary is useful under bailout guarantees as it changes capital usage in the desired direction by ensuring that banks monitor more and lend less.

The desirability of relying exclusively on capital taxation to mitigate moral hazard is questionable, however, if one bears in mind that a higher than “normal” capital tax-rate also reduces the level of production in the economy. This observation suggests that moral hazard might be better addressed with the use of alternative instruments such as an effort-adjusted capital requirement. When the latter is in force, the private level of monitoring is greater, and the lending level lower when compared to the no-regulation case. Furthermore, the analysis also establishes that the capital tax-rate increases with a decrease in supervisory effectiveness. Indeed, it is highest when financial supervision is least effective, and conversely.

The conclusion arising from these results is clear: bailout guarantees should only co-exist with some form of effective banking supervision to ensure the effects of moral hazard are mitigated. As such, it reinforces the view that emerging economies can signal their financial reputation and contribute to reducing the risk of future crises only by implementing good governance and effective supervisory procedures in their financial systems. In addition, it implies that a successful microeconomic financial policy will allow emerging economies to have lower capital tax-rates making investment more attractive.

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## 8 Appendix

### 8.1 Nature of Banking

#### 8.1.1 Banking Technology

Let  $\Pr(G) = \lambda(s^t)$  denote the *ex-ante* probability of full repayment in the absence of microeconomic uncertainty, and  $\Pr(B) = 1 - \lambda(s^t)$  that of default. Upon monitoring, a bank refines this observational signal by (imperfectly) classifying firms as being “good” or “bad”. Let  $e \in (0, 1)$  denote the monitoring level and  $c(e)$  the monitoring cost function, which is increasing, strictly convex and with  $c(0) = 0$  and  $\lim_{e \rightarrow 1} c(e) = +\infty$ . Monitoring is costly due to the real resources expended in evaluating loans. After monitoring, a firm that is correctly classified as “good” is allowed to continue onto the capital set-up stage with probability  $\Pr(A|G) = \alpha(e)$ .

However, banks can incur a *type-II* error with probability  $\Pr(A|B) = \beta(e)$  when a “bad” firm is incorrectly allowed to produce. The *ex-post* loan acceptance probability is therefore given by

$$\Pr(A) = \alpha(e)\lambda(s^t) + \beta(e)(1 - \lambda(s^t)) \quad \forall e \in (0, 1)$$

where  $\frac{\partial \Pr(A)}{\partial e} \leq 0$  and  $\frac{\partial^2 \Pr(A)}{\partial e^2} \geq 0$ . Banking technology is monotonic with  $\alpha'(e) \geq 0, \alpha''(e) \leq 0$  and  $\beta'(e) \leq 0, \beta''(e) \geq 0$ . Although a full effort level would ensure that only the “good” firms are retained, i.e.  $\alpha(1) = 1$  and  $\beta(1) = 0$ , it will be prohibitively expensive to implement. As such, banks will always choose an incomplete level of monitoring in equilibrium.<sup>17</sup>

#### 8.1.2 Banking Profits

A bank’s profit function will differ according to whether or not it monitors its loan portfolio. When it does not (and assuming no bailouts), the profit function is given by

$$\Pi^B(l, \tilde{r}^l) = (1 + \tilde{r}^l)\lambda(s^t)l(s^t) - \varphi(l) - R(s^t)d(s^t) - E(s^t)R^*l^*(s^t) - c(k^B) \quad (\text{A1})$$

where  $(1 + \tilde{r}^l)$  is the after-tax gross interest rate on lending and  $\varphi(l) = \frac{l^2}{2}$  is the real cost of lending  $l(s^t)$  units.<sup>18</sup> The internal cost of financing a loan is

<sup>17</sup>Note also that a zero effort level will not improve precision beyond the original signal so that  $\Pr(A \cap G) = \lambda(s^t)$  and  $\Pr(A \cap B) = 1 - \lambda(s^t)$ , implying that loans are accepted with probability one.

<sup>18</sup>The variable  $s^t$  will sometimes be omitted in order to simplify the analysis’ notation.



$R(s^t)d(s^t)$  while  $E(s^t)R^*l^*(s^t)$  is the external cost, which depends directly on the exchange rate in  $t = 2$ . Finally, the term  $c(k^B)$  is the opportunity cost of banking and equals  $E(s^t)R^*k^B$ , given a bank's access to external capital markets.

When a bank monitors its loan portfolio, its profit function is instead given by

$$\Pi^B(e, l, \tilde{r}^l) = F(e, \tilde{r}^l, \lambda(s^t))l(s^t) - \varphi(l) - R(s^t)d(s^t) - E(s^t)R^*l^*(s^t) - c(k^B) \quad (\text{A2})$$

where  $F(e, \tilde{r}^l, \lambda(s^t))$  is the gross return on lending (exclusive of both loan issuance and financing costs), which is calculated as follows:

$$F(e, \tilde{r}^l, \lambda(s^t)) = 1 + \alpha(e)\lambda(s^t)\tilde{r}^l - \beta(e)(1 - \lambda(s^t)) - c(e)$$

The above calculation takes into account four elements: first, a monitoring cost; second, a return of  $(1 + \tilde{r}^l)$  associated with the proportion of “good” firms  $(\alpha(e)\lambda(s^t))$  that were *not* shutdown; third, the capital recovered from the proportion of firms that *were* shutdown, which equals  $1 - \alpha(e)\lambda(s^t) - \beta(e)(1 - \lambda(s^t))$ ; and, fourth, a zero return due to the default of “bad” firms that were erroneously allowed to initiate production. Note that the function  $F(\cdot)$  is concave due to the properties of banking technology. In subsequent analysis, it will be useful to define the *net* return on lending (exclusive of loan issuance costs only), i.e.  $F(e, \tilde{r}^l, \lambda(s^t)) - E(s^t)R^*$ , which is subject to the two following assumptions:

**Assumption A1:** *For all effort levels, the net return on lending is positive in the first state and negative in the second, i.e.*

$$\begin{aligned} F(e, \tilde{r}^l, \lambda_1) &> E_1 R^* \\ F(e, \tilde{r}^l, \lambda_2) &< E_2 R^* \end{aligned}$$

In other words, the combined effect of an exchange rate devaluation and of a lower loan-repayment rate leads a bank to experience a loss in the second state.

**Assumption A2:** *For all effort levels, the expected net return on lending is positive, i.e.*

$$F(e, \tilde{r}^l, \bar{\lambda}) > \bar{E} R^*$$

The above assumption ensures that a bank's expected profit is positive (even when bailout guarantees do not exist).<sup>19</sup> Finally, consider the economic intuition underlying a bank's decision regarding whether or not it should monitor. A bank answers this question by comparing its expected profits under the two alternative scenarios, which leads to the following definition:

**Definition A1:** Let  $\lambda$  denote a generic expected proportion of “good” firms. A bank's monitoring opportunity set is given by  $\Phi(\lambda) = (0, e^o(\lambda))$ , where  $e^o(\lambda)$  is uniquely given by

$$(1 - \beta(e^o))(1 - \lambda) - (1 - \alpha(e^o))\lambda\tilde{r}^l = c(e^o)$$

The underlying reasoning is as follows: the left-hand side (LHS) is the net benefit associated with monitoring. It is calculated as the proportion of capital recovered from firms correctly identified as “bad” less the opportunity cost associated with the early termination of “good” firms, which would otherwise have yielded an additional return of  $\lambda\tilde{r}^l$ . A bank monitors its loan portfolio if the gains are at least as great as its monitoring costs, which appear on the right-hand side (RHS). The effort level at which a bank is indifferent between monitoring or not monitoring is denoted by  $e^o(\lambda)$ .

### 8.1.3 Banking Equilibrium

**Proof of Proposition 1:** Given a bank's risk-neutral preferences, its momentary utility function is linear in consumption so that function (4) becomes

$$V = \delta \sum_{s^t} \pi(s^t|s_1) \Pi^B(e, l, \tilde{r}^l, s^t)$$

upon the substitution of the budget constraint. The optimisation problem's FOC are then given by

$$\delta \sum_{s^t} \pi(s^t|s_1) F_e(e, \tilde{r}^l, \lambda(s^t)) l = 0 \quad (\text{A3})$$

$$\delta \sum_{s^t} \pi(s^t|s_1) [F(e, \tilde{r}^l, \lambda(s^t)) - E(s^t)R^* - \varphi_l(l)] = 0 \quad (\text{A4})$$

which can be rewritten as

$$(1 - q)F_e(e, \tilde{r}^l, \lambda_1)l + qF_e(e, \tilde{r}^l, \lambda_2)l = 0 \quad (\text{A3}')$$

$$(1 - q)F(e, \tilde{r}^l, \lambda_1) + qF(e, \tilde{r}^l, \lambda_2) - \bar{E}R^* - \varphi_l(l) = 0 \quad (\text{A4}')$$

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<sup>19</sup>In this case, a bank faces an expected loan repayment rate of  $\bar{\lambda} = (1 - q)\lambda_1 + q\lambda_2$  and an expected exchange rate of  $\bar{E} = (1 - q)E_1 + qE_2$ .

Equation (A4') establishes that the optimal level of lending is positive when evaluated at the optimal monitoring effort level due to assumption A2. In turn, this implies that (A3') is only satisfied when  $F_e(e, \tilde{r}^l, \bar{\lambda}) = 0$ , as  $q > 0$ .<sup>20</sup> Equations (10) and (11) follow immediately from the definition of  $F(e, \tilde{r}^l, \bar{\lambda})$  while (12) is simply the market equilibrium condition of zero excess demand. The second-order conditions, namely

$$\begin{aligned} F_{ee}(e, \tilde{r}^l, \bar{\lambda}) &\leq 0 \\ -\varphi_{ll}(l) &\leq 0 \end{aligned}$$

are also satisfied given the assumptions regarding banking technology and loan issuance costs.

**Proof of Proposition 2:** In conjunction with assumption A1, the reasoning used in the previous proposition's proof establishes the results obtained here. Note that the FOC under bailout guarantees are given by

$$(1 - q)F_e(e, \tilde{r}^l, \lambda_1)l = 0 \quad (\text{A5})$$

$$(1 - q)\{F(e, \tilde{r}^l, \lambda_1) - E_1 R^* - \varphi_l(l)\} = 0 \quad (\text{A6})$$

which are only satisfied if  $F(e, \tilde{r}^l, \lambda_1) - E_1 R^* - \varphi_l(l) = 0$  and  $F_e(e, \tilde{r}^l, \lambda_1) = 0$  as  $q > 0$ .

**Proof of Proposition 3** A casual inspection of the bankers' optimal solution under the two bailout regimes, *vis.* equations (10)-(12) and (15)-(17), reveals that these are specific instances of a more general system of equations:

$$\begin{aligned} H^1 &\equiv F(\hat{e}, \tilde{r}^l, \lambda) - ER^* - \varphi_l(l) = 0 \\ H^2 &\equiv \alpha'(\hat{e})\lambda\tilde{r}^l - \beta'(\hat{e})(1 - \lambda) - c'(\hat{e}) = 0 \\ H^3 &\equiv \int_{z \in Z} \hat{l} - D(r^l) = 0 \end{aligned}$$

where  $\lambda$  and  $E$  denote a generic loan repayment and exchange rate respectively. Note that the conditions of the implicit function theorem are satisfied for the above system, as all partial derivatives exist (by assumption) and as the Jacobian is non-zero when evaluated at the point of equilibrium:

$$|J| = \begin{vmatrix} H_l^1 & H_e^1 & H_{r^l}^1 \\ H_l^2 & H_e^2 & H_{r^l}^2 \\ H_l^3 & H_e^3 & H_{r^l}^3 \end{vmatrix} = \begin{vmatrix} -\varphi_{ll}(\hat{l}) & 0 & \alpha(\hat{e})\lambda \\ 0 & F_{ee}(\hat{e}, \tilde{r}^l, \lambda) & \alpha'(\hat{e})\lambda \\ 1 & 0 & -\frac{\partial D(r^l)}{\partial r^l} \end{vmatrix} > 0$$

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<sup>20</sup>The expected value of  $F_e(\cdot)$  is equal to the value of  $F_e(\cdot)$  when evaluated at the expected loan repayment rate ( $\bar{\lambda}$ ). This property is due to the functional form of banking technology and the fact that  $\lambda(s^t)$  is the only variable subject to stochastic uncertainty.

where  $H_e^2 = \alpha''(\hat{e})\lambda\tilde{r}^l - \beta''(\hat{e})(1 - \lambda) - c''(\hat{e}) < 0$ . Using Cramer's rule, the effect of a change in the loan repayment rate on the optimal monitoring is

$$\frac{d\hat{e}}{d\lambda} = \frac{\begin{vmatrix} H_l^1 & -H_\lambda^1 & H_{r^l}^1 \\ H_l^2 & -H_\lambda^2 & H_{r^l}^2 \\ H_l^3 & -H_\lambda^3 & H_{r^l}^3 \end{vmatrix}}{|J|} < 0$$

since  $H_\lambda^1 = \alpha(\hat{e})\tilde{r}^l + \beta(\hat{e}) > 0$ ,  $H_\lambda^2 = \alpha'(\hat{e})\tilde{r}^l + \beta'(\hat{e}) < 0$  and  $H_\lambda^3 = 0$ .<sup>21</sup> Similarly, it can be shown that

$$\begin{aligned} \frac{d\hat{l}}{d\lambda} &= \frac{\begin{vmatrix} -H_\lambda^1 & H_e^1 & H_{r^l}^1 \\ -H_\lambda^2 & H_e^2 & H_{r^l}^2 \\ -H_\lambda^3 & H_e^3 & H_{r^l}^3 \end{vmatrix}}{|J|} > 0 \\ \frac{dr^l}{d\lambda} &= \frac{\begin{vmatrix} H_l^1 & H_e^1 & -H_\lambda^1 \\ H_l^2 & H_e^2 & -H_\lambda^2 \\ H_l^3 & H_e^3 & -H_\lambda^3 \end{vmatrix}}{|J|} < 0 \end{aligned}$$

which means that  $\frac{d\hat{e}}{dr^l} = -\frac{H_{r^l}^1}{H_e^1} > 0$  for a given loan repayment rate. Moreover, optimal lending decreases when  $z(s^t)$  increases as  $\frac{d\hat{l}}{dr^l} > 0$  for a given monitoring level.

## 8.2 Taxation

### 8.2.1 Workers' Optimisation Problem

A worker maximises (1) subject to constraints (2) and (3), taking the labour tax-rate as given parametrically. For any given set of expected government policy variables, the result of the worker's problem is the consumption function for each period and the second period's labour supply function. The

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<sup>21</sup>The sign of  $H_\lambda^2$  is due the properties of banking technology and because  $\tilde{r}^l \in (0, 1)$ . In particular, recall that  $\alpha'(e) \geq 0$ ,  $\beta'(e) \leq 0$  and  $\frac{\partial \Pr(A)}{\partial e} \leq 0$ . These assumptions imply that  $0 < \alpha'(\hat{e})\lambda \leq -\beta'(\hat{e})(1 - \lambda) < -\beta'(\hat{e})$ , or alternatively  $\beta'(\hat{e}) < \alpha'(\hat{e})\lambda + \beta'(\hat{e}) < 0$  whenever  $\forall \lambda \in (0, 1)$ .

FOC are given by the following Euler equations

$$c_1^W(s^t) : \sum_{s^t} \pi(s^t|s_1) \{u_c(c_1^W(s^t)) - \nu\} = 0 \quad (\text{A7})$$

$$c_2^W(s^t) : \sum_{s^t} \pi(s^t|s_1) \{\delta(u_c(c_2^W(s^t), 1 - n(s^t)) - \nu R^{-1}(s^t))\} = 0 \quad (\text{A8})$$

$$n(s^t) : \sum_{s^t} \pi(s^t|s_1) \{\nu R^{-1}(s^t) \tilde{w}(s^t) - \delta u_n(c_2^W(s^t), 1 - n(s^t))\} = 0 \quad (\text{A9})$$

and have the usual interpretations. The Lagrangean multiplier of the worker's lifetime budget constraint is denoted by  $\nu$ .

### 8.2.2 Government's Ramsey Problem

The Ramsey problem is solved using the dual approach in which tax-rates are viewed as the decision variables. Since the Lagrangean formulation (19) already incorporates the firms' FOC and the equilibrium factor market outcomes, the government simply chooses the level of  $c_1^W(s^t)$ ,  $c_2^W(s^t)$ ,  $c_2^B(s^t)$ ,  $n(s^t)$  and  $k(s^t)$  that maximises its objective function. In the case of labour and capital, the respective FOC are as follows:

$$n(s^t) : \sum_{s^t} \pi(s^t|s_1) [-\theta \delta u_n(c_2^W(s^t), 1 - n(s^t)) + \mu_2 R^{-1}(s^t) w(s^t) + \mu_1 R^{-1}(s^t) (Q_n(s^t) - \tilde{w}(s^t) + \eta_2 \delta u_{nn}(\cdot, \cdot))] = 0 \quad (\text{A10})$$

$$k(s^t) : \sum_{s^t} \pi(s^t|s_1) R^{-1}(s^t) \{\mu_1 (Q_k - \tilde{r}^l - B_k(s^t)) + \mu_2 [F(e, r^l, \lambda(s^t)) - E(s^t) R^* - \varphi_k(k(s^t))] - \eta_3\} = 0 \quad (\text{A11})$$

as  $u_{cn}(\cdot, \cdot) = 0$  and  $F_e(\cdot, \cdot, \cdot) = 0$  due to utility function separability and equilibrium monitoring behaviour respectively while  $\varphi_{kk}(\cdot) = 1$ .

## 8.3 Financial Supervision

### 8.3.1 Capital-Requirement Design

Using profit function (A2), note that  $l(s^t)$  are a bank's assets,  $d(s^t)$  and  $l^*(s^t)$  its domestic and foreign liabilities respectively, and  $k^B$  its own capital. In conjunction with the accounting identity,  $l(s^t) = k^b + d(s^t) + l^*(s^t)$ , and the equilibrium condition w.r.t. to financing costs, i.e.  $E(s^t) R^* = R(s^t)$ , banking profits can be rewritten as

$$\Pi^B(e, l, \tilde{r}^l, s^t) = (F(e, \tilde{r}^l, \lambda(s^t)) - E(s^t) R^*) l(s^t) - \varphi(l) + E(s^t) R^* k^B - c(k^B)$$

where the return on assets per unit loan (net of financing costs only) is given by  $F(e, \tilde{r}^l, s^t) - E(s^t)R^*$ . Consider now the case of no bailouts: a bank's problem is to choose  $e \in \Phi(\bar{\lambda})$  that maximises

$$V = (1 - q)\{(F(e, \tilde{r}^l, \lambda_1) - E_1 R^*)l - \varphi(l)\} + q\{(F(e, \tilde{r}^l, \lambda_2) - E_2 R^*)l - \varphi(l)\} \quad (\text{A12})$$

subject to constraints (5) and (6). Objective function (A12) is derived by taking into account the fact that a household which invests  $k^B$  in banking could alternatively have invested it in an international asset yielding  $\bar{E}R^*k^B$ . Hence,  $c(k^B)$  is equal to  $\bar{E}R^*k^B$  in equilibrium.

In the case of bailout guarantees, however, a bank receives  $E_1 R^*k^B$  in the first state and nothing in the second. The equilibrium condition here is  $(1 - q)c(k^B(\tilde{e})) = \bar{E}R^*k^B(\tilde{e})$  so that

$$\begin{aligned} V &= (1 - q)\{(F(\tilde{e}, \tilde{r}^l, \lambda_1) - E_1 R^*)l - \varphi(l) + E_1 R^*k^B(\tilde{e}) - c(k^B(\tilde{e}))\} \\ &= (1 - q)\{(F(\tilde{e}, \tilde{r}^l, \lambda_1) - E_1 R^*)l - \varphi(l)\} - qE_2 R^*k^B(\tilde{e}) \quad (\text{A13}) \end{aligned}$$

on the assumption that a capital-requirement is in place. The latter's design must take into account a bank's response to it, which the regulator achieves by considering the nature of monitoring under (A12) and (A13). The respective FOC are as follows:

$$\left( (1 - q) \frac{\partial F(e, \tilde{r}^l, \lambda_1)}{\partial e} + q \frac{\partial F(e, \tilde{r}^l, \lambda_2)}{\partial e} \right) l = 0 \quad (\text{A14})$$

$$\left( (1 - q) \frac{\partial F(e, \tilde{r}^l, \lambda_1)}{\partial e} - qE_2 R^* \frac{\partial k^B(\tilde{e})}{\partial \tilde{e}} \frac{\partial \tilde{e}}{\partial e} \right) l = 0 \quad (\text{A14}')$$

After comparing (A14) and (A14'), it is obvious that monitoring effort will only be the same in both cases if

$$-qE_2 R^* \frac{\partial k^B(\tilde{e})}{\partial \tilde{e}} \frac{\partial \tilde{e}}{\partial e} = q \frac{\partial F(e, \tilde{r}^l, \lambda_2)}{\partial e}$$

In practice, however, the enforceability of the capital requirement depends on the regulator's imperfect perception of a bank's monitoring level, which implies that<sup>22</sup>

$$\frac{\partial k^B(\tilde{e})}{\partial e} = -\frac{1}{E_2 R^*} \frac{\partial F(\tilde{e}, \tilde{r}^l, \lambda_2)}{\partial e} \leq 0 \quad (\text{A15})$$

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<sup>22</sup>i.e.  $-qE_2 R^* \frac{\partial k^B(\tilde{e})}{\partial \tilde{e}} \frac{\partial \tilde{e}}{\partial e} = q \frac{\partial F(\tilde{e}, \tilde{r}^l, \lambda_2)}{\partial \tilde{e}} \frac{\partial \tilde{e}}{\partial e}$ . The respective monitoring levels are identical only when  $\gamma = 1$ . As this is not the case, the regulator will never be able to ensure that a bank pursues  $\hat{e}^s$ .

Let  $\hat{e}^{cr}$  denote a bank's monitoring level when a capital requirement is in force. Note that  $\frac{\partial k^B(\tilde{e})}{\partial e}|_{e=\hat{e}^{cr}} \leq 0$  necessarily implies that  $\frac{\partial F(\tilde{e}, \tilde{r}^l, \lambda_1)}{\partial \hat{e}^{cr}}|_{e=\hat{e}^{cr}} \leq 0$  in (A14'), or equivalently that  $\hat{e}^{cr} \geq \hat{e}^p$  due to the properties of  $F(e, \tilde{r}^l, \lambda_1)$ . In other words, an increase in monitoring lowers the capital requirement, which is clearly desirable both for the bank and for the regulator.<sup>23</sup> This observation implies that a capital-requirement must be designed with the restriction  $\frac{\partial F(\tilde{e}, \tilde{r}_{cr}^l, \lambda_2)}{\partial e} > 0$  in mind so as to ensure that  $\frac{\partial k^B(\tilde{e})}{\partial e} < 0$ . After integrating (A15), it is easy to show that the restriction is given by

$$C + F(\tilde{e}, \tilde{r}_{cr}^l, \lambda_2) > 0$$

where  $C$  is a constant chosen by the regulator. Subject to this restriction, the enforceable capital requirement is defined as

$$k_{cr}^B(\tilde{e}) = \frac{\varphi(l) + (E_2 R^* - F(\tilde{e}, \tilde{r}^l, \lambda_2))l}{E_2 R^*} \quad (\text{A16})$$

Finally, it can be shown after further manipulation that there exists an upper limit for the capital requirement,

$$0 < k_{cr}^B(\tilde{e}) < \frac{\varphi(l) + (E_2 R^* + C)l}{E_2 R^*}$$

which is only binding when the bank has a negative incentive to pursue a *lower* level of monitoring, i.e. when  $\forall e \in (0, \hat{e}^p)$ .

### 8.3.2 Proof of Proposition 7

Let  $H$  denote FOC (A11), which implicitly defines the optimal capital tax-rate. In equilibrium, the tax-rate will depend directly on monitoring level in the following manner:  $\frac{dz}{de} = -\frac{H_e}{H_z} < 0$  since

$$\begin{aligned} H_e &= \sum_{s^t} \pi(s^t | s_1) R^{-1}(s^t) \{ -\mu_1 B_{ke}((s^t)) + \mu_2 [\alpha'(\hat{e}) \lambda(s^t) (r^l(s^t) - \tilde{r}^l(s^t))] \} > 0 \\ H_z &= \sum_{s^t} \pi(s^t | s_1) R^{-1}(s^t) \{ \mu_1 + \mu_2(s^t) \alpha(\hat{e}) \lambda(s^t) \} r^l > 0 \end{aligned}$$

Note that  $B_{ke}(s^t) = -F_e(\hat{e}, \tilde{r}^l, \lambda(s^t))$  is non-positive  $\forall \hat{e} \in [\hat{e}^p(\lambda_1, \tilde{r}^l), \hat{e}^s(\bar{\lambda}, \tilde{r}^l)]$  in the second state, given the paper's assumptions.

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<sup>23</sup> On the other hand, when  $\frac{\partial k^B(\tilde{e})}{\partial e}|_{e=\hat{e}^{cr}} \geq 0$ , it is true that  $\frac{\partial F(\tilde{e}, \tilde{r}^l, \lambda_1)}{\partial \hat{e}^{cr}}|_{e=\hat{e}^{cr}} \geq 0$ , or equivalently that  $\hat{e}^{cr} \leq \hat{e}^p$ . Here, there is a perverse incentive for a bank to reduce monitoring.

## **Sequence of Events**

### **Date 1**

#### **Announcement Stage**

Government commits itself to a fiscal policy.

Banking regulator announces the regulatory regime.

#### **Banks' Lending Game**

Banking competition sets lending and borrowing rates.

Firms apply for loans and lending takes place.

#### **Hidden Information**

Nature reveals to firms their likelihood of a successful capital set-up process.

#### **Banks' Monitoring Game**

Banks decide monitoring levels.

Decision regarding loan recalls made.

#### **Regulation Stage**

Financial supervision takes place.

### **Date 2**

#### **Exogenous Regime Shock**

Exchange rate and loan performance regime observed.

Borrowing and lending contracts are executed.

Production takes place.

Government expenditure plans implemented.

## **Figure 1**



## Moral Hazard

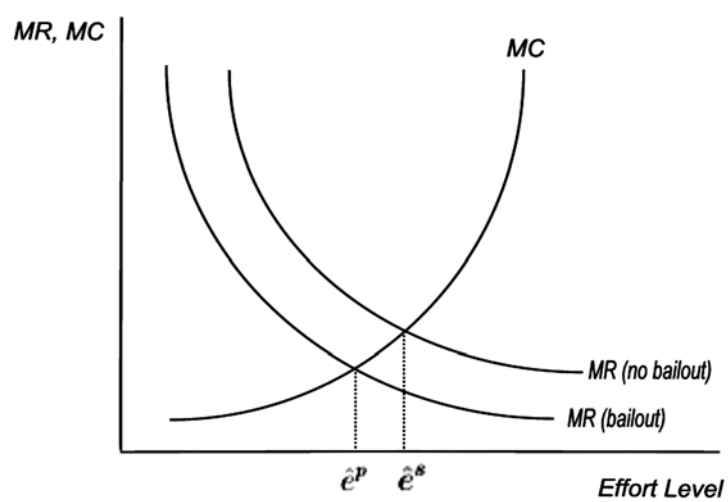


Figure 2